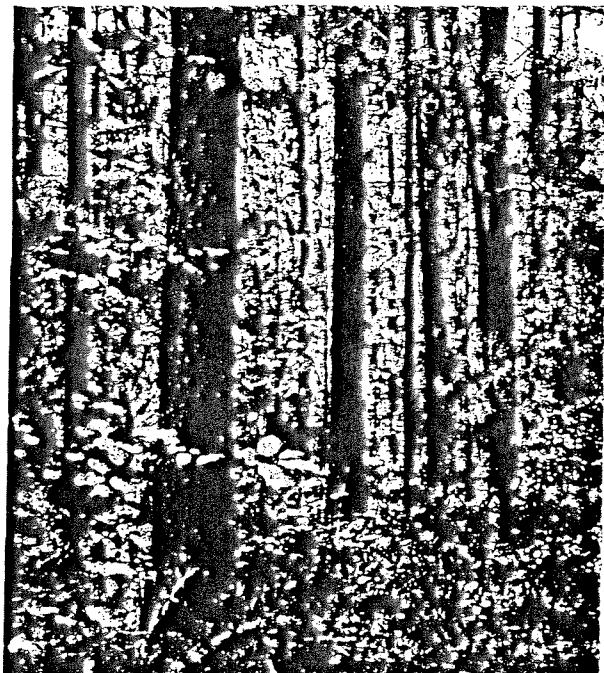


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TABLES FOR ESTIMATING TOTAL-TREE WEIGHTS, STEM WEIGHTS, AND VOLUMES OF PLANTED AND NATURAL SOUTHERN PINES IN THE SOUTHEAST

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TABLES FOR ESTIMATING TOTAL-TREE WEIGHTS, STEM WEIGHTS, AND VOLUMES OF PLANTED AND NATURAL SOUTHERN PINES IN THE SOUTHEAST

By
Alexander Clark III and Joseph R. Saucier



INTRODUCTION

An increasing amount of southern pine timber is now coming from young, fast-growing plantations rather than older, natural stands. USDA Forest Service projections indicate that by the year 2000, half of the southern pine timber harvested will be from plantations. Total-tree and tree-component weight and volume equations and tables are needed for plantation-grown trees. Tables are available for estimating plantation-pine stem weight and volume but not for estimating weight and volume of the total tree (Bailey and others 1982, 1985). Total-tree and tree-component equa-

tions are available for the major southern pines growing in natural stands (Saucier and others 1981). However, these tables are not applicable to trees cruised by saw-log merchantable height or height to a 4-inch d.o.b. top.

This paper provides: (1) Equations and tables for estimating total-tree weights, stem weights, and volumes of plantation-grown loblolly (*Pinus taeda* L.) and slash (*P. elliottii* Engelm.) pines when d.b.h. and total height or height to a 4-inch d.o.b. top are known; (2) Tables of total-tree

weights, stem weights, and volumes for southern pines growing in natural stands when d.b.h. and total height, height to 4-inch top, or saw-log merchantable height are known. Combined tables are presented for loblolly and shortleaf pines (*P. echinata* Mill.) growing in natural stands in the Piedmont and for loblolly, slash, and longleaf pines (*P. palustris* Mill.) growing in natural stands in the Coastal Plain. Tables are also presented for planted loblolly pines in the Piedmont and planted slash pines in the Coastal Plain.

METHODS

Equations and tables were developed from data collected in several studies. These studies were conducted by the Southeastern Forest Experiment Station in cooperation with the Georgia Forestry Commission, University of Georgia School of Forest Resources, forest industries, and Southern Region of USDA Forest Service.

In all studies except one, a stratified-random sample of trees was selected to obtain equal numbers of trees in all diameter classes. In the loblolly pine plantation study conducted in cooperation with the University of Georgia School of Forest Resources, trees were sampled from crown-class strata. Three sample trees were felled in each of 135 study plantations. Two trees were from the dominant or codominant crown class, while the third tree was alternately selected from the intermediate or suppressed crown class. Only trees sampled from stands 15 years or older were included in the analysis. The locations where planted and naturally seeded trees were sampled are shown in Figure 1. Appendix Table 69 shows means and ranges in tree measurements in each diameter class. Ages of plantation loblolly pines ranged from 15 to 35 years and averaged 22 years on the Piedmont. Ages of plantation-grown slash pines on the Coastal Plain ranged from 10 to 31 years and averaged 21 years.

Field Data Collection

Each sample tree was felled, and diameters outside bark (d.o.b.) were measured at the butt, at 2 feet, and at 4.5 feet, and at 4 foot-intervals up the bole in natural stands and at 5-foot intervals in planted stands. In natural stands, heights to the saw-log or 7-inch top and to 4-, and 2-inch tops were recorded. In planted stands, heights to 6-, 4-, and 2-inch tops were recorded. Cross-sectional disks were removed from the stem and branches of study trees for laboratory determination of specific gravity, moisture content, and percentage of bark. Foliage weight was estimated from randomly selected sample branches in each study tree.

The branches of all trees were cut from the stem and weighed. In natural stands, the stems of pulpwood-size

were weighed to a 4- and 2-inch d.o.b. top. The stems of sawtimber-size trees (trees \geq 9.0 inches d.b.h. with a minimum of one 16-foot grade 3 log) were weighed to a 7-inch d.o.b. or merchantable saw-log top and to 4-, and 2-inch d.o.b. tops. Stems of saplings (trees 1.0 to 4.9 inches d.b.h.) were weighed in one piece to the tip. Stems of plantation trees sampled by the Forest Service in cooperation with the Georgia Forestry Commission and forest industries were weighed to 6-, 4-, and 2-inch tops in the field. Stem weights of planted trees sampled in cooperation with the University of Georgia were estimated from stem measurements and physical properties of cross-sectional disks.

Laboratory Data Collection

Disks collected from each tree were processed in the laboratory to determine the percentage of bark on a weight basis and the moisture content and specific gravity of wood and bark, separately. These determinations provided the data necessary for computing green and dry weights per cubic foot of stem wood, branchwood, and bark.

Equations for predicting diameters inside bark (d.i.b.) were developed from d.o.b. and d.i.b. stem-disk measurements and the d.o.b. and height measurements taken at 4- or 5-foot intervals up the stem of each tree. Volumes of wood in stems to saw-log and 6-, 4-, and 2-inch d.o.b. tops and to tips were calculated by Smalian's formula. For planted loblolly trees sampled in cooperation with the University of Georgia, green weight per cubic foot of each 5-foot bolt was estimated from moisture contents and specific gravities of the disks at the ends of each bolt. In these computations, disk values were weighted by disk cross-sectional area. Bolt wood green weight was then calculated from estimated bolt weight per cubic foot and bolt wood volume. Bolt weight of wood plus bark was then estimated from the weighted percentage of bark in end disks. Green weight per cubic foot of branchwood was calculated from weighted values for branchwood specific gravity and moisture content. Cubic-foot volume of branchwood was computed by dividing branch green weight by its green weight per cubic foot. Volume of wood in whole trees was computed by

branches to the volume of wood in the stem.

Data Analysis

Regression equations were developed to predict green weight of wood, bark, and needles and volume of wood only in the total tree above a 0.5-foot stump, in the stem from butt to tip, and in the saw-log stem to a variable top. Independent variables were: diameter breast height (D), total height (Th), height to a 4-inch d.o.b. top (H4), and saw-log merchantable height (Mh).

A logarithmic transformation (base 10) was used to obtain a relatively homogeneous variance, which is assumed in regression analysis. Thus, regression equations for estimating weight and volume were calculated with the models:

$$\log Y = a + b \log X + \epsilon \quad (1)$$

$$\log Y = a+b \log X_1+c \log X_2+\epsilon \quad (2)$$

where: Y = predicted component weight or volume

$$X = D^2, D^2 Th, D^2 H_4, \text{ or } D^2 Mh$$

$$X_1 = D^2$$

$$X_2 = Th, H_4, \text{ or } Mh$$

ϵ = experimental error

a,b,c = regression coefficients

Equation (1) fit the planted data best and was selected for use with d.b.h. and total height and d.b.h. and height to a 4-inch d.o.b. top to predict the weight and volume of plantation-grown trees. Plots of residuals showed that equations (1) and (2) underestimated total-tree and total-stem weight and volume of natural pines \geq 14 inches when one equation was used for all trees 1 inch and larger (Clark and others 1985). When equation (2) was used with $D^2 + Mh$ for sawtimber trees \geq 9 inches the residuals indicated good predictability. Equation (2) was therefore selected for use with d.b.h. and saw-log merchantable height. Two equations were developed for d.b.h. and total height and d.b.h. and height to a 4-inch top for natural pines. For the total height variable, one equation (3) for trees $<$ 5 inches, and another (4) for trees \geq 5 inches d.b.h. were developed. For the height to a 4-inch-top variable, one

quation (3) for trees < 9 inches, and another (4) for trees \geq 9 inches d.b.h. were developed.

The procedure outlined in Draper and Smith (1981) for fitting two linear equations with known point of intersection was used to develop the following equations:

$$\log Y_p = a + b \log X + \epsilon \quad (3)$$

$$\log Y_s = a + b \log (i^2 H) + c \log (D^2/i^2) + \epsilon \quad (4)$$

where: Y_p = predicted component weight or volume for trees < 9 inches d.b.h.

Y_s = predicted component weight or volume for trees \geq 9 inches d.b.h.

$X = D^2, D^2 Th, \text{ or } D^2 H_4$

$i = 5$ when $X = D^2 Th$ or 9 when $X = D^2 H_4$

$H = Th \text{ or } H_4$

$D = \text{d.b.h.}$

$\epsilon = \text{experimental error}$

a,b,c = regression coefficients

When logarithmic estimates are converted back to original units, they are biased downward because the antilogarithm of an estimated mean is the geometric rather than the arithmetic mean (Cunia 1964). To adjust for this bias, a correction factor was computed and applied to each model using Baskerville's (1972) procedure. The final equations including correction factors were simplified to:

$$Y = a(D^2)^b (Mh)^c \quad (5)$$

$$Y_p = a(D^2 H)^b \quad (6)$$

$$Y_s = a(D^2)^b (H)^c \quad (7)$$

An exponential ratio equation was used to estimate the proportion of predicted total-stem weight or volume to a specified top d.o.b. for both natural and planted trees:

$$Y_R = e^{a(d^b D^c)} \quad (8)$$

where: Y_R = predicted ratio of stem weight or volume to top d.o.b./total-stem weight or volume

d = specified stem-top diameter in inches

D = tree diameter at breast height in inches

a,b,c = regression coefficients

e = base of natural log = 2.71828

The exponential ratio model shown below was developed to estimate a ratio for expanding saw-log stem weight or volume of naturally grown trees to any d.o.b. top above the saw-log top.

$$Y_R = e^{(a(Mh))^b [(1.0 - d^2/0.6084 D^2)^2]^c} \quad (9)$$

where: Y_R = predicted ratio of stem weight or volume to top d.o.b./saw-log stem weight or volume

Mh = saw-log merchantable height in feet

d = specified top diameter in inches

D = tree diameter at breast height in inches

0.6084 = constant based on average form class--(0.78)²

a,b,c, = regression coefficients

e = base of natural log

RESULTS

Weight and Volume Tables

Equations for weight and volume were developed for planted pines using d.b.h. in combination with total height and height to 4-inch d.o.b. top and for natural pines using d.b.h. in combination with total height, height to 4-inch d.o.b. top, and saw-log merchantable height. Equations were developed to predict the weight of wood, bark, and needles in the total tree and the weight of wood and bark in the stem from butt to tip and butt to saw-log merchantable top. Equations were also developed to predict the volume of wood in cubic feet in the total tree, total stem, and saw-log stem. Equations were developed for estimating total-tree and total-stem weight and volume using d.b.h. in combination with total height or height to a 4-inch d.o.b. top--using equation (6) for plantation trees and equations (5 and 6) for natural stand trees. Ratio equation (8) was used to estimate the proportions of total stems in the sections from the stump to a 7-inch and a 4-inch d.o.b. top for natural stand pine and to a 6-, 4-, and 2-inch d.o.b. top for planted pine. Equation (5) was used to predict

the weight and volume of the total tree and saw-log stem to a 7-inch d.o.b. top or to the point where a grade 3 saw-log stopped in natural pine trees \geq 9 inches d.b.h. Ratio equation (9) was used to expand the saw-log stem to a 4-inch d.o.b. top.

These equations were used to develop tables showing predicted weight and volume of the total tree, the stem to 4-inch d.o.b. top, and the stem to a 7-inch or saw-log-merchantable top for natural loblolly, slash, and longleaf pines growing in the Coastal Plain and natural loblolly and shortleaf pines growing in the Piedmont. These equations were also used to develop tables showing predicted weight and volume of the total tree and stem to a 6-, 4-, and 2-inch d.o.b. top for planted slash pine in the Coastal Plain and planted loblolly in the Piedmont. The tables based on d.b.h. and total height or height to a 4-inch top show weight and volume by 1-inch d.b.h. classes and 10-foot height intervals. The tables based on d.b.h. and saw-log merchantable height show weight and volume by 1-inch d.b.h. classes and $\frac{1}{2}$ -log intervals.

The various weight and volume tables are presented in series for natural and planted trees by species groups and by the d.b.h. and height combinations.

The volume of pulpwood in sawtimber-size trees can be estimated by subtracting predicted stem weight or volume to the merchantable saw-log top or 7-inch top from the predicted stem weight or volume to the 4-inch top. Likewise, crown weight or volume can be estimated by subtracting predicted stem values to the 4-inch top from predicted total-tree weight or volume.

All tables for naturally grown trees are good predictors of tree weight and volume, but tables based on d.b.h. and total height or d.b.h. and height to 4-inch d.o.b. top are the best indicators of stem weight or volume to the 4-inch top. Tables based on d.b.h. and saw-log merchantable height are the best estimators of the saw-log merchantable stem because tables based on total height and height to a 4-inch top estimate the stem to a fixed 7-inch top rather than to where a grade 3 log stopped.

Trees of similar diameter and height in natural stands may vary in weight and volume because of differences in crown size and stem taper related to stand stocking. Therefore, tables presented here for naturally grown pines should be applied to trees growing in fully stocked stands.

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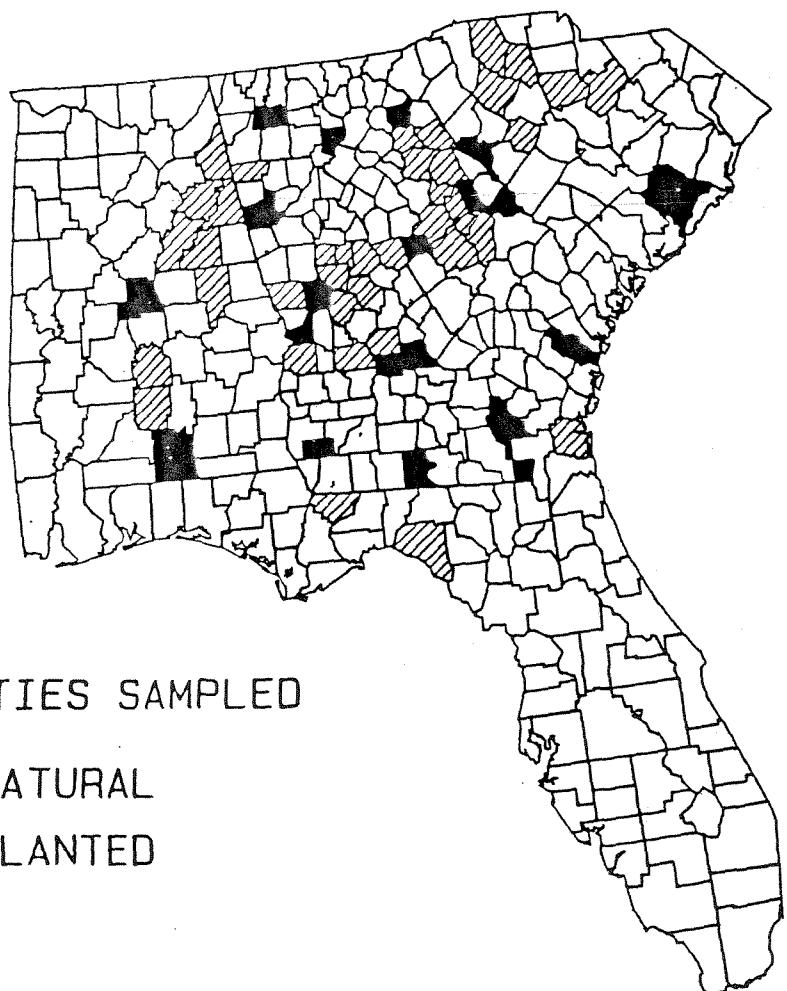


Figure 1.--Map of Alabama, Georgia, South Carolina and northern Florida showing counties in which natural pine stands and planted stands were sampled for development of regional species equations.

Table 21.--Predicted green weight of stem wood and bark to 4-inch d.o.b. top for planted slash pine in the Coastal Plain, based on d.b.h. and total height 1/ 2/

D.b.h. class (inches)	Total-tree height (feet)						
	30	40	50	60	70	80	90
----- Pounds 3/ -----							
5	69	91	113	134	156		
6	132	174	216	257	298		
7	200	264	328	391	453	515	
8	274	362	449	535	620	705	
9	354	468	580	691	801	911	1020
10	441	582	721	860	997	1134	1270
11		706	875	1043	1210	1375	1541
12		840	1041	1240	1439	1636	1832
13		983	1219	1452	1685	1916	2145
14		1137	1409	1679	1948	2215	2481

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $Y = 0.20458 (D^2 Th)^{0.96236}$

$$Y_R = e^{(-0.94583 (d)^{4.56744} (D)^{-4.26956})}$$

Table 23.--Predicted green weight of total tree (wood, bark, and foliage) for planted slash pine in the Coastal Plain, based on d.b.h. and height to the 4-inch d.o.b. top 1/ 2/

D.b.h. class (inches)	Tree height to 4-inch d.o.b. (feet)						
	10	20	30	40	50	60	70
----- Pounds 3/ -----							
5	121	203	275	341			
6	158	267	361	449			
7		336	456	565	668	767	
8		411	557	691	817	937	
9		490	664	825	975	1118	1255
10		574	778	966	1142	1309	1470
11			898	1114	1318	1511	1696
12			1023	1270	1502	1722	1933
13				1154	1432	1693	1942
14					1290	1601	1893
						2170	2436
							2693

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $Y = 1.90965 (D^2 H_4)^{0.75067}$

Table 22.--Predicted green weight of stem wood and bark to 6-inch d.o.b. top for planted slash pine in the Coastal Plain, based on d.b.h. and total height 1/ 2/

D.b.h. class (inches)	Total-tree height (feet)						
	30	40	50	60	70	80	90
----- Pounds 3/ -----							
7	99	131	162	193	224	255	
8	184	243	301	359	416	474	
9	279	367	456	543	630	716	802
10	378	499	619	737	855	973	1089
11		637	790	941	1092	1242	1391
12		782	970	1156	1341	1524	1707
13		935	1159	1381	1602	1822	2041
14		1096	1358	1619	1878	2135	2392

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $Y = 0.20458 (D^2 Th)^{0.96236}$

$$Y_R = e^{(-0.94583 (d)^{4.56744} (D)^{-4.26956})}$$

Table 24.--Predicted green weight of stem wood and bark to 2-inch d.o.b. top for planted slash pine in the Coastal Plain, based on d.b.h. and height to the 4-inch d.o.b. top 1/ 2/

D.b.h. class (inches)	Tree height to 4-inch d.o.b. (feet)						
	10	20	30	40	50	60	70
----- Pounds 3/ -----							
5	100	168	227	282			
6	133	223	302	375			
7		282	382	474	560	642	
8		346	468	581	686	786	
9		413	559	693	819	939	1054
10		484	655	812	960	1100	1235
11			756	937	1107	1269	1424
12			861	1068	1262	1446	1623
13			971	1204	1422	1630	1830
14			1085	1345	1589	1822	2044
							2259

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $Y = 1.64209 (D^2 H_4)^{0.74813}$

$$Y_R = e^{(-0.94583 (d)^{4.56744} (D)^{-4.26956})}$$

Table 25.--Predicted green weight of stem wood and bark to 4-inch d.o.b. top for planted slash pine in the Coastal Plain, based on d.b.h. and height to the 4-inch d.o.b. top ^{1/} ^{2/}

D.b.h. class (inches)	Tree height to 4-inch d.o.b. (feet)							
	10	20	30	40	50	60	70	80
----- Pounds ^{3/} -----								
5	59	99	134	166				
6	104	175	237	294				
7	249	337	418	494	567			
8	322	436	541	639	732			
9	395	536	664	785	900	1009	1116	
10	471	637	790	934	1070	1201	1327	
11		742	920	1087	1246	1399	1546	
12		850	1054	1246	1428	1603	1771	
13		962	1193	1410	1616	1813	2004	
14		1078	1336	1579	1810	2031	2244	

^{1/} Blocked-in area indicates range of data.

^{2/} Includes 0.5-foot stump allowance.

^{3/} $y = 1.64209 (D^2 H_4)^{0.74813}$

$$y_R = e^{(-0.94583 (d)^{4.56744} (D)^{-4.26956})}$$

Table 27.--Predicted green weight of total tree (wood, bark, and foliage) for planted loblolly pine in the Piedmont, based on d.b.h. and total height ^{1/} ^{2/}

D.b.h. class (inches)	Total-tree height (feet)							
	20	30	40	50	60	70	80	90
----- Pounds ^{3/} -----								
3	29	43	58	72				
4	51	77	103	129				
5		121	161	201	241	281		
6		174	231	289	347	405		
7		315	393	472	551	629	708	
8		411	514	617	719	822	925	
9		520	650	780	910	1040	1170	
10		642	803	963	1124	1284	1445	
11		971	1165	1360	1554	1748		
12		1156	1387	1618	1849	2080		
13		1356	1627	1899	2170	2441		
14		1573	1887	2202	2516	2830		

^{1/} Blocked-in area indicates range of data.

^{2/} Includes 0.5-foot stump allowance.

^{3/} $y = 0.16115 (D^2 H_4)^{0.99956}$

Table 26.--Predicted green weight of stem wood and bark to 6-inch d.o.b. top for planted slash pine in the Coastal Plain, based on d.b.h. and height to the 4-inch d.o.b. top ^{1/} ^{2/}

D.b.h. class (inches)	Tree height to 4-inch d.o.b. (feet)							
	20	30	40	50	60	70	80	
----- Pounds ^{3/} -----								
7	123	167	207	244	280			
8	216	293	363	429	492			
9	311	421	522	617	707	793	877	
10	404	547	678	801	918	1030	1138	
11	670	831	982	1125	1263	1395		
12	792	983	1161	1331	1493	1650		
13	915	1135	1341	1537	1725	1906		
14	1039	1288	1522	1745	1958	2164		

^{1/} Blocked-in area indicates range of data.

^{2/} Includes 0.5-foot stump allowance.

^{3/} $y = 1.64209 (D^2 H_4)^{0.74813}$

$$y_R = e^{(-0.94583 (d)^{4.56744} (D)^{-4.26956})}$$

Table 28.--Predicted green weight of stem wood and bark to 2-inch d.o.b. top for planted loblolly pine in the Piedmont, based on d.b.h. and total height ^{1/} ^{2/}

D.b.h. class (inches)	Total-tree height (feet)							
	20	30	40	50	60	70	80	90
----- Pounds ^{3/} -----								
3	18	27	36	45				
4	38	58	78	97				
5		96	128	161	194	227		
6		141	189	237	286	335		
7		261	327	394	461	529	596	
8		344	431	519	608	696	785	
9		437	549	661	774	887	1000	
10		543	681	821	960	1100	1241	
11		828	997	1167	1337	1507		
12		989	1191	1394	1597	1801		
13		1165	1402	1641	1880	2120		
14		1355	1631	1909	2187	2466		

^{1/} Blocked-in area indicates range of data.

^{2/} Includes 0.5-foot stump allowance.

^{3/} $y = 0.11576 (D^2 H_4)^{1.01935}$

$$y_R = e^{(-1.33918 (d)^{4.40499} (D)^{-4.24150})}$$

Table 29.--Predicted green weight of stem wood and bark to 4-inch d.o.b. top for planted loblolly pine in the Piedmont, based on d.b.h. and total height 1/ 2/

D.b.h. class (inches)	Tree-tree height (feet)						
	30	40	50	60	70	80	90
----- Pounds 3/ -----							
5	51	69	87	104	122		
6	106	142	178	215	251		
7	168	225	282	340	397	455	514
8	235	316	396	477	558	640	721
9		416	522	628	735	842	950
10		525	659	794	929	1065	1200
11		645	810	975	1141	1308	1475
12		776	974	1173	1373	1573	1774
13		918	1152	1387	1623	1860	2097
14		1071	1344	1619	1894	2170	2447

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $y = 0.11576 (D^2 Th)^{1.01935}$

$$y_R = e^{(-1.33918 (d)^{4.40499} (D)^{-4.24150})}$$

Table 31.--Predicted green weight of total tree (wood, bark, and foliage) for planted loblolly pine in the Piedmont based on d.b.h. and height to the 4-inch d.o.b. top 1/ 2/

D.b.h. class (inches)	Tree height to 4-inch d.o.b. (feet)							
	10	20	30	40	50	60	70	80
----- Pounds 3/ -----								
5	105	181	249	312	372			
6	140	241	331	415	494			
7		307	422	529	630	726	820	
8		378	520	652	776	895	1010	
9		455	626	784	934	1077	1215	1349
10		537	738	924	1101	1270	1433	1592
11		857	1073	1279	1475	1664	1848	
12		982	1230	1465	1691	1908	2118	
13		1113	1395	1661	1917	2163	2401	
14		1250	1567	1866	2153	2429	2697	

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $y = 1.38892 (D^2 H_4)^{0.78378}$

Table 30.--Predicted green weight of stem wood and bark to 6-inch d.o.b. top for planted loblolly pine in the Piedmont, based on d.b.h. and total height 1/ 2/

D.b.h. class (inches)	Tree-tree height (feet)						
	30	40	50	60	70	80	90
----- Pounds 3/ -----							
7	77	103	130	156	183	209	236
8	151	203	255	307	359	412	464
9		318	399	481	563	645	727
10		443	556	669	783	897	1012
11		576	723	870	1018	1167	1316
12		717	900	1084	1268	1453	1639
13		867	1089	1311	1535	1758	1983
14		1028	1290	1553	1818	2083	2349

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $y = 0.11576 (D^2 Th)^{1.01935}$

$$y_R = e^{(-1.33918 (d)^{4.40499} (D)^{-4.24150})}$$

Table 32.--Predicted green weight of stem wood and bark to 2-inch d.o.b. top for planted loblolly pine in the Piedmont, based on d.b.h. and height to the 4-inch d.o.b. top 1/ 2/

D.b.h. class (inches)	Tree height to 4-inch d.o.b. (feet)							
	10	20	30	40	50	60	70	80
----- Pounds 3/ -----								
5	84	145	201	253	303			
6	114	198	274	344	412			
7		255	353	444	530	614	694	
8		317	438	551	659	762	862	
9		383	529	666	796	921	1042	1160
10		454	627	789	943	1091	1235	1374
11		731	920	1099	1272	1439	1601	
12		840	1057	1264	1462	1654	1840	
13		955	1202	1437	1662	1880	2092	
14		1075	1353	1618	1871	2117	2355	

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $y = 1.04334 (D^2 H_4)^{0.79941}$

$$y_R = e^{(-1.33918 (d)^{4.40499} (D)^{-4.24150})}$$

Table 53.--Predicted volume of total tree (wood only) for planted slash pine in the Coastal Plain, based on d.b.h. and total height 1/ 2/

D.b.h. class (inches)	Total-tree height (feet)							
	20	30	40	50	60	70	80	90
----- Cubic feet 3/ -----								
3	0.37	0.56	0.76	0.95	1.15			
4	0.67	1.02	1.37	1.72	2.07			
5		1.61	2.16	2.71	3.26	3.82		
6		2.33	3.13	3.93	4.74	5.55		
7		3.20	4.29	5.39	6.50	7.61	8.72	
8		4.20	5.64	7.09	8.54	10.00	11.46	
9		5.35	7.18	9.02	10.86	12.72	14.58	16.45
10		6.63	8.90	11.18	13.48	15.78	18.09	20.40
11			10.82	13.59	16.38	19.18	21.98	24.80
12			12.93	16.24	19.57	22.91	26.27	29.63
13			15.23	19.13	23.05	26.99	30.94	34.90
14			17.72	22.26	26.83	31.41	36.01	40.62

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $y = 0.00184 (D^2 Th)^{1.02293}$

Table 55.--Predicted volume of stem wood to 4-inch d.o.b. top for planted slash pine in the Coastal Plain, based on d.b.h. and total height 1/ 2/

D.b.h. class (inches)	Total-tree height (feet)						
	30	40	50	60	70	80	90
----- Cubic feet 3/ -----							
5	0.89	1.19	1.49	1.80	2.10		
6	1.69	2.26	2.83	3.40	3.98		
7	2.59	3.46	4.34	5.22	6.10	6.99	
8	3.59	4.80	6.02	7.24	8.46	9.68	
9	4.69	6.28	7.87	9.46	11.06	12.67	14.27
10	5.90	7.90	9.91	11.92	13.93	15.95	17.97
11		9.69	12.14	14.61	17.07	19.55	22.03
12		11.63	14.58	17.54	20.50	23.47	26.44
13		13.73	17.22	20.71	24.21	27.72	31.23
14		16.01	20.07	24.14	28.22	32.31	36.40

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $y = 0.00183 (D^2 Th)^{1.01315}$

$$y_R = e^{(-0.52346 (d)^{4.63924} (D)^{-4.00064})}$$

Table 54.--Predicted volume of stem wood to 2-inch d.o.b. top for planted slash pine in the Coastal Plain, based on d.b.h. and total height 1/ 2/

D.b.h. class (inches)	Total-tree height (feet)							
	20	30	40	50	60	70	80	90
----- Cubic feet 3/ -----								
3	0.30	0.45	0.61	0.76	0.91			
4	0.60	0.91	1.21	1.52	1.83			
5		1.47	1.96	2.46	2.96	3.46		
6		2.14	2.87	3.60	4.33	5.06		
7		2.94	3.94	4.94	5.94	6.95	7.95	
8		3.87	5.18	6.49	7.81	9.13	10.45	
9		4.92	6.58	8.25	9.92	11.60	13.28	14.97
10		6.09	8.15	10.22	12.29	14.37	16.46	18.54
11			9.89	12.40	14.92	17.44	19.97	22.50
12			11.80	14.80	17.80	20.81	23.83	26.85
13			13.89	17.41	20.94	24.48	28.03	31.58
14			16.14	20.23	24.34	28.45	32.57	36.70

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $y = 0.00183 (D^2 Th)^{1.01315}$

$$y_R = e^{(-0.52346 (d)^{4.63924} (D)^{-4.00064})}$$

Table 56.--Predicted volume of stem wood to 6-inch d.o.b. top for planted slash pine in the Coastal Plain, based on d.b.h. and total height 1/ 2/

D.b.h. class (inches)	Total-tree height (feet)						
	30	40	50	60	70	80	90
----- Cubic feet 3/ -----							
7	1.22	1.63	2.05	2.46	2.88	3.29	
8	2.31	3.09	3.87	4.66	5.44	6.23	
9	3.56	4.77	5.98	7.19	8.40	9.62	10.84
10	4.93	6.60	8.27	9.95	11.63	13.32	15.00
11	6.40	8.56	10.73	12.91	15.09	17.28	19.47
12	7.96	10.66	13.36	16.07	18.79	21.51	24.24
13	9.63	12.89	16.16	19.44	22.73	26.02	29.32
14	11.41	15.27	19.15	23.03	26.92	30.82	34.73

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $y = 0.00183 (D^2 Th)^{1.01315}$

$$y_R = e^{(-0.52346 (d)^{4.63924} (D)^{-4.00064})}$$

Table 57.--Predicted volume of total tree (wood only) for planted slash pine in the Coastal Plain, based on d.b.h. and height to 4-inch d.o.b. top 1/ 2/

D.b.h. class (inches)	Tree height to 4-inch d.o.b. (feet)							
	10	20	30	40	50	60	70	80
Cubic feet 3/								
5	1.39	2.40	3.31	4.16				
6	1.85	3.21	4.42	5.56				
7	4.10	5.65	7.10	8.47	9.79			
8	5.06	6.98	8.77	10.47	12.10			
9	6.10	8.42	10.57	12.62	14.58	16.48	18.32	
10	7.21	9.95	12.49	14.91	17.23	19.47	21.65	
11	11.57	14.53	17.35	20.04	22.65	25.18		
12	13.28	16.68	19.91	23.01	26.00	28.91		
13	15.08	18.94	22.61	26.13	29.52	32.82		
14	16.96	21.30	25.43	29.38	33.20	36.91		

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

$$3/ Y = 0.01740 (D^2 H_4)^{0.79293}$$

Table 59.--Predicted volume of stem wood to 4-inch d.o.b. top for planted slash pine in the Coastal Plain, based on d.b.h. and height to the 4-inch d.o.b. top 1/ 2/

D.b.h. class (inches)	Tree height to 4-inch d.o.b. (feet)							
	10	20	30	40	50	60	70	80
Cubic feet 3/								
5	0.78	1.34	1.84	2.30				
6	1.35	2.33	3.20	4.01				
7	3.33	4.57	5.73	6.83	7.88			
8	4.34	5.96	7.47	8.90	10.27			
9	5.38	7.39	9.26	11.04	12.73	14.37	15.96	
10	6.45	8.87	11.12	13.24	15.28	17.25	19.15	
11	7.57	10.41	13.04	15.54	17.93	20.24	22.47	
12	8.74	12.01	15.05	17.93	20.69	23.35	25.93	
13	9.95	13.67	17.14	20.42	23.56	26.59	29.52	
14	11.21	15.41	19.31	23.00	26.54	29.95	33.26	

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

$$3/ Y = 0.01713 (D^2 H_4)^{0.78464}$$

$$Y_R = e^{(-0.52346 (d)^{4.63924} (D)^{-4.00064})}$$

Table 58.--Predicted volume of stem wood to 2-inch d.o.b. top for planted slash pine in the Coastal Plain, based on d.b.h. and height to the 4-inch d.o.b. top 1/ 2/

D.b.h. class (inches)	Tree height to 4-inch d.o.b. (feet)							
	10	20	30	40	50	60	70	80
Cubic feet 3/								
5	1.28	2.20	3.02	3.79				
6	1.72	2.96	4.07	5.10				
7	3.79	5.21	6.53	7.77	8.97			
8	4.68	6.44	8.07	9.61	11.09			
9	5.64	7.75	9.71	11.57	13.35	15.07	16.73	
10	6.66	9.15	11.47	13.66	15.76	17.79	19.76	
11	10.63	13.32	15.87	18.32	20.67	22.95		
12	12.19	15.28	18.20	21.00	23.70	26.32		
13	13.82	17.33	20.64	23.82	26.88	29.85		
14	15.53	19.46	23.19	26.76	30.20	33.53		

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

$$3/ Y = 0.01713 (D^2 H_4)^{0.78464}$$

$$Y_R = e^{(-0.52346 (d)^{4.63924} (D)^{-4.00064})}$$

Table 60.--Predicted volume of stem wood to 6-inch d.o.b. top for planted slash pine in the Coastal Plain, based on d.b.h. and height to the 4-inch d.o.b. top 1/ 2/

D.b.h. class (inches)	Tree height to 4-inch d.o.b. (feet)							
	20	30	40	50	60	70	80	
Cubic feet 3/								
7	1.57	2.16	2.70	3.22	3.71			
8	2.79	3.84	4.81	5.73	6.61			
9	4.08	5.61	7.04	8.38	9.67	10.91	12.12	
10	5.39	7.42	9.28	11.06	12.76	14.40	15.99	
11	9.20	11.53	13.74	15.85	17.89	19.86		
12	11.01	13.80	16.44	18.96	21.40	23.77		
13	12.84	16.09	19.17	22.11	24.96	27.71		
14	14.70	18.42	21.95	25.32	28.58	31.73		

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

$$3/ Y = 0.01713 (D^2 H_4)^{0.78464}$$

$$Y_R = e^{(-0.52346 (d)^{4.63924} (D)^{-4.00064})}$$

Table 61.--Predicted volume of total tree (wood only) for planted loblolly pine in the Piedmont, based on d.b.h. and total height 1/ 2/

D.b.h. class (inches)	Total-tree height (feet)							
	20	30	40	50	60	70	80	90
Cubic feet 3/								
3	0.36	0.55	0.74	0.93				
4	0.65	0.99	1.34	1.68				
5		1.57	2.11	2.66	3.21	3.76		
6		2.29	3.08	3.87	4.67	5.48		
7			4.23	5.32	6.42	7.53	8.63	9.75
8				5.57	7.01	8.45	9.91	11.37
9					12.83			
10						14.49	16.36	
11							20.32	
12								24.73
13								29.59
14								34.89
								40.64

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $Y = 0.00159 (D^2 Th)^{1.02725}$

Table 63.--Predicted volume of stem wood to 4-inch d.o.b. top for planted loblolly pine in the Piedmont, based on d.b.h. and total height 1/ 2/

D.b.h. class (inches)	Total-tree height (feet)							
	30	40	50	60	70	80	90	
Cubic feet 3/								
5	0.74	0.99	1.24	1.50	1.76			
6	1.53	2.06	2.59	3.13	3.66			
7	2.44	3.28	4.12	4.97	5.82	6.68	7.54	
8	3.43	4.62	5.80	7.00	8.20	9.41	10.62	
9		6.09	7.66	9.23	10.82	12.41	14.00	
10		7.71	9.69	11.69	13.70	15.71	17.73	
11		9.48	11.92	14.38	16.85	19.33	21.81	
12		11.42	14.36	17.32	20.29	23.27	26.26	
13		13.52	17.00	20.50	24.02	27.55	31.10	
14		15.79	19.86	23.95	28.06	32.18	36.32	

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $Y = 0.00159 (D^2 Th)^{1.02725}$

$$Y_R = e^{(-1.54900 (d)^4 - 37037 (d)^{-4} - 29173)}$$

Table 62.--Predicted volume of stem wood to 2-inch d.o.b. top for planted loblolly pine in the Piedmont, based on d.b.h. and total height 1/ 2/

D.b.h. class (inches)	Total-tree height (feet)							
	20	30	40	50	60	70	80	90
Cubic feet 3/								
3	0.25	0.38	0.50	0.63				
4	0.55	0.83	1.12	1.40				
5		1.38	1.86	2.34	2.82	3.30		
6		2.05	2.75	3.46	4.17	4.89		
7			3.80	4.78	5.77	6.76	7.75	8.75
8				5.02	6.31	7.61	8.92	10.23
9					11.55			
10						14.73		
11							22.28	
12								26.65
13								31.42
14								36.60

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $Y = 0.00159 (D^2 Th)^{1.02725}$

$$Y_R = e^{(-1.54900 (d)^4 - 37037 (d)^{-4} - 29173)}$$

Table 64.--Predicted volume of stem wood to 6-inch d.o.b. top for planted loblolly pine in the Piedmont, based on d.b.h. and total height 1/ 2/

D.b.h. class (inches)	Total-tree height (feet)							
	30	40	50	60	70	80	90	
Cubic feet 3/								
7	1.14	1.53	1.92	2.32	2.71	3.11	3.51	
8	2.23	3.00	3.77	4.55	5.33	6.12	6.90	
9		4.70	5.91	7.12	8.34	9.57	10.80	
10			6.53	8.22	9.91	11.61	13.32	15.03
11				8.50	10.68	12.89	15.10	17.32
12					10.59	13.31	16.06	18.81
13						12.81	16.11	19.43
14							15.19	19.10
								23.03
								26.98
								30.95
								34.93

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $Y = 0.00159 (D^2 Th)^{1.02725}$

$$Y_R = e^{(-1.54900 (d)^4 - 37037 (d)^{-4} - 29173)}$$

Table 67.--Predicted volume of stem wood to 4-inch d.o.b. top for planted loblolly pine in the Piedmont based on d.b.h. and height to the 4-inch d.o.b. top 1/ 2/

D.b.h. class (inches)	Tree height to 4-inch d.o.b. (feet)							
	10	20	30	40	50	60	70	80
----- Cubic feet 3/ -----								
5	0.66	1.15	1.59	1.99	2.38			
6	1.27	2.20	3.04	3.82	4.56			
7	3.25	4.49	5.65	6.74	7.80	8.81		
8	4.30	5.94	7.47	8.93	10.32	11.67		
9	5.38	7.42	9.33	11.15	12.89	14.57	16.20	
10	6.48	8.95	11.25	13.44	15.54	17.57	19.54	
11	10.53	13.24	15.82	18.29	20.68	22.99		
12	12.18	15.32	18.30	21.15	23.91	26.59		
13	13.90	17.48	20.87	24.13	27.28	30.34		
14	15.69	19.72	23.56	27.24	30.79	34.24		

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $y = 0.01582 (D^2 H_4)^{0.79584}$

$$y_R = e^{(-1.54900(d)^{4.37037}(D)^{-4.29417})}$$

Table 66.--Predicted volume of stem wood to 2-inch d.o.b. top for planted loblolly pine in the Piedmont based on d.b.h. and height to the 4-inch d.o.b. top 1/ 2/

D.b.h. class (inches)	Tree height to 4-inch d.o.b. (feet)							
	10	20	30	40	50	60	70	80
----- Cubic feet 3/ -----								
5	1.24	2.15	2.97	3.74	4.47			
6	1.69	2.93	4.05	5.09	6.07			
7	3.77	5.21	6.55	7.82	9.04	10.22		
8	4.68	6.46	8.12	9.70	11.22	12.68		
9	5.65	7.81	9.82	11.72	13.55	15.32	17.04	
10	6.69	9.24	11.62	13.88	16.04	18.14	20.17	
11	10.76	13.53	16.16	18.68	21.12	23.49		
12	12.36	15.54	18.57	21.46	24.27	26.99		
13	14.05	17.66	21.09	24.39	27.57	30.66		
14	15.81	19.87	23.74	27.44	31.02	34.50		

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $y = 0.01582 (D^2 H_4)^{0.79584}$

$$y_R = e^{(-1.54900(d)^{4.37037}(D)^{-4.29417})}$$

Table 68.--Predicted volume of stem wood to 6-inch d.o.b. top for planted loblolly pine in the Piedmont, based on d.b.h. and height to the 4-inch d.o.b. top 1/ 2/

D.b.h. class (inches)	Tree height to 4-inch d.o.b. (feet)							
	20	30	40	50	60	70	80	
----- Cubic feet 3/ -----								
7	1.52	2.10	2.64	3.15	3.64	4.12	4.58	
8	2.80	3.87	4.87	5.82	6.72	7.60	8.45	
9	4.15	5.73	7.21	8.61	9.95	11.25	12.51	
10	5.50	7.59	9.55	11.40	13.18	14.90	16.57	
11	9.45	11.88	14.18	16.40	18.54	20.62		
12	11.30	14.21	16.97	19.62	22.18	24.67		
13	13.18	16.57	19.79	22.88	25.87	28.77		
14	15.09	18.98	22.66	26.20	29.62	32.94		

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $y = 0.01582 (D^2 H_4)^{0.79584}$

$$y_R = e^{(-1.54900(d)^{4.37036}(D)^{-4.29417})}$$

Table 65.--Predicted volume of total tree (wood only) for planted loblolly pine in the Piedmont based on d.b.h. and height to the 4-inch d.o.b. top 1/ 2/

D.b.h. class (inches)	Tree height to 4-inch d.o.b. (feet)							
	10	20	30	40	50	60	70	80
----- Cubic feet 3/ -----								
5	1.41	2.45	3.38	4.25	5.08			
6	1.89	3.27	4.52	5.69	6.79			
7	4.19	5.78	7.27	8.68	10.04	11.35		
8	5.18	7.15	8.99	10.74	12.42	14.04		
9	6.25	8.63	10.85	12.96	14.98	16.94	18.84	
10	7.39	10.20	12.83	15.32	17.72	20.03	22.28	
11	11.87	14.93	17.83	20.62	23.31	25.93		
12	13.64	17.15	20.48	23.68	26.78	29.78		
13	15.49	19.48	23.27	26.90	30.42	33.83		
14	17.43	21.92	26.18	30.27	34.23	38.07		

1/ Blocked-in area indicates range of data.

2/ Includes 0.5-foot stump allowance.

3/ $y = 0.01738 (D^2 H_4)^{0.79624}$

Table 69.--Mean and range of tree measurements, by species and tree-size classes

Tree d.b.h. class size (inches)	Sample trees	<u>D.b.h.</u>		<u>Total Height</u>	<u>Height to 4-in. d.o.b. top</u>	<u>Height to saw- log merch. top</u>	<u>D.o.b. at saw- log merch. top</u>
		Average	Range	Average : Range	Average : Range	Average : Range	Average : Range
Number - - <u>Inches</u> - <u>Feet</u> - <u>Inches</u> - -							
All trees	1285	12.0	1.1-24.0	69	8-102	-	-
> 5.0	1185	12.8	5.0-24.0	72	35-102	57	12-90
≥ 9.0	933	14.2	9.1-24.0	75	46-102	62	32-90
NATURAL COASTAL PLAIN PINE (LOBLOLLY, SLASH, LONGLEAF)							
All trees	1026	11.6	1.1-20.4	66	12-107	-	-
> 5.0	926	12.6	5.1-20.4	60	32-107	55	13-95
≥ 9.0	720	14.0	9.1-20.4	74	49-107	61	39-95
NATURAL PIEDMONT PINE (LOBLOLLY, SHORTLEAF)							
All trees	196	7.1	2.5-14.4	54	23-79	-	-
≥ 5.0	111	8.0	5.0-14.4	58	32-79	39	14-67
PLANTED COASTAL PLAIN PINE (SLASH)							
All trees	220	7.6	3.3-15.3	54	25-88	-	-
≥ 5.0	139	8.9	5.0-15.3	61	37-88	42	10-70
PLANTED PIEDMONT PINE (LOBLOLLY)							
All trees	220	7.6	3.3-15.3	54	25-88	-	-
≥ 5.0	139	8.9	5.0-15.3	61	37-88	42	10-70